

# Analysis of Work in Retirement

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Prepared for the North Carolina Retirement Systems

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# PART ONE: CLIENT BRIEF

## Project organization

This project comes in five parts:

1. Client brief: The client brief is an executive summary. It is for North Carolina Retirement Systems policy staff and assumes the reader knows the background. I focus on the policy question, results, and how the results are relevant to the retirement system.
2. Academic brief: This section gives background information and includes details about the dataset and methods. This section is primarily for the sake of being thorough and to meet the academic requirements of this project. It might be a tedious section for someone who already knows the subject or who is not interested in the particulars of how I got my results.
3. Appendix one, results tables: Appendix one has tables of regression results to which I refer throughout the paper.
4. Appendix two, statistical concepts and equations: I give a short overview of the fundamental statistical concepts of least squares regression and survival analysis. This section is written to be transparent about the methods and equations I used, even if they are standard practice. It was also a good exercise for me to think carefully whether the base assumptions of my models held or not. I go through those assumptions briefly and relate them to this project. I walk through a proof of the validity of least-squares regression when those assumptions hold. In other words, I try to show in math and in words why someone could believe the results mean anything. I include relevant likelihood functions and some important equations I use to calculate results. For specifics on all calculations, look in appendix three.
5. Appendix three, code for R software: In the spirit of giving retirement system staff useful work, I did all analyses using the free and widely used R statistical software. In appendix three, I include all code so the client's staff members can reproduce and improve upon my work, if they want to. Providing the code also allows the client to update this analysis as more and better data become available.

## Purpose

Retirement system staff are in the midst of contemplating changes to policies limiting work in retirement for members of the Local Governmental Employees' Retirement System (LGERS) and the Teachers' and State Employees' Retirement System (TSERS). Until recently, the retirement system had no comprehensive data about how many of its retirees return to work, when, for how long, and how much they earn in doing so.

The project analyzes a new dataset including that information for all LGERS<sup>1</sup> and TSERS<sup>2</sup> retirees who worked in retirement -- from Jan. 1, 2007 to Dec. 31, 2013 -- for employers in the same systems from which they retired, while continuing to receive their retirement benefits.

I try to answer two questions as best I can:

1. Which characteristics, if any, suggest retirees in the dataset were willing to work for less in retirement, holding constant pre-retirement compensation and other factors?
2. Which characteristics influenced how long those retirees worked?

### **Relevance to retirement system policy**

This paper is intended to give retirement system staff a better understanding of the population of retirees who choose to work for employers within their former systems, while continuing to receive benefits. My results have implications for a number of different policies the retirement system is considering. But I do not try to come up with a solution to a particular problem.

I also do not try to predict how retirees would behave after a particular policy change, or even how they will behave after Dec. 31, 2013. Those are different questions and require a different approach, though this analysis would make for a good starting point. If retirement system staff have reason to believe retirees' past behavior will be similar to their future behavior, my results could be helpful in thinking about what might happen after a change. But again, I did not try to predict how retirees would behave under new circumstances, and this paper should not be read as such.

Instead, my goal is to contribute valuable information to process of developing policies related to retirees who return to work. With that in mind, I include all code and a discussion of all underlying assumptions of the analysis in appendices, for retirement staff to apply to future policy questions if they want to.

The two questions have different policy implications, described in turn below.

#### *Question One: Earnings in retirement*

I have worked almost a year, part time, as a policy analyst for the retirement system. Throughout the year, retirement staff members have begun to develop short- and long-term policy changes related to retirees who return to work within the systems from which they retired. Among the options retirement staff have considered or could consider are policies to lift restrictions on how much retirees can work for employers within the system from which they receive benefits, and how much they can earn while doing so.

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<sup>1</sup> Local Governmental Employees' Retirement System

<sup>2</sup> Teachers' and State Employees' Retirement System

The issue of easing retiree work restrictions is rooted in specific cases retirement staff have dealt with and in general demographic trends of recent years: Retirees are living longer, working longer, and polls suggest more retirees are interested in leaving work in stages, rather than all at once.

Such policies often have an actuarial cost for the retirement systems. If there were no limits on work in retirement, retirees receiving benefits could fill positions that contributing employees otherwise would fill. One solution to offset the actuarial cost of any type of return-to-work policy change would be to charge public employers a percentage of the retiree's earnings, as the systems do for active employees. But the offset would have consequences: Employers might oppose the idea, making the policy change difficult to achieve. Employers could pay retirees less to accommodate the surcharge, but if retirees are unwilling to work for a lower wage it would blunt the effect of loosening work restrictions.

It is possible retirees are willing to work for less the more they receive in retirement benefits. If that were the case, state and local governments might be able to hire from the experienced pool of retirees at a relative bargain. State policy in previous years, for example, allowed retired teachers in North Carolina public schools to work with fewer restrictions, with the goal of helping to meet educational workforce needs. The retirement system and public schools might be interested to know whether retired teachers on average were willing to work for less in retirement than they did at the peak of their careers.

In general, if certain retirees are willing to work for less, it suggests a policy to remove work restrictions and impose a surcharge is more feasible and might have a greater effect on public-sector human resources than it would if the surcharge limited work opportunities for retirees.

#### *Question Two: Length of work in retirement*

This question is more generic than the first but it nonetheless gives valuable context to policy discussions about changes to policies for retirees who return to work. The retirement system now has largely anecdotal information about what types of retirees work most while continuing to receive their benefits. Survival analysis estimates factors influencing lengths of time before a certain event, in this case the length of work in retirement before quitting. The system's new comprehensive dataset allows me to estimate relationships among retiree characteristics and how long they work.

For example, I estimate whether retirees who work in public schools on average work longer than retirees who work for other public employers, controlling for other factors such as benefit amount, income and economic factors. With that information, the retirement system has a better sense of how potential changes to return-to-work policy could affect different types of retirees.

## **Results**

A summary of results and my interpretation of what the results could mean for retirement system policy are below. More detail is in the academic brief.

### *Measures of earnings and length of work*

The measure of earnings reported below is a retiree's total earnings in the dataset divided by the number of weeks he or she worked. Earnings are in 2013 dollars, adjusted using the GDP implicit price deflator.

Length of work in retirement is the number of weeks, including parts of weeks, between a person's first date of the first pay period of work in retirement and the last date of the last pay period.

### *Important note about results*

Since the three North Carolina retirement systems in this dataset are defined benefit plans, a person's retirement allowance is a product of years of service, average final compensation, and a small constant factor of around 0.0185. That factor depends on the retirement system and has changed little over the years.

Since final compensation is controlled for in the regression for my first question, another way to interpret the effect of benefit amount is that it captures the effect of years of service as member of the retirement system. I stick with the benefit variable because I did not have years of service in the dataset and chose not to include a proxy variable for it in my final models. I did not want it to appear that I was fabricating data. I did create a proxy variable for years of service and included it in the two final models, replacing compensation and benefit, to see how much that mattered. It didn't, much, but that is not surprising because it is just one of the replaced variables times the other. The proxy is not an exact measure of years of service because employees who do not reach a threshold amount of service has reduced benefits, so the benefit amount follows a slightly different formula. Full results are in appendix one.

You could choose to think of the results below as capturing the effect of years of service, as opposed to benefit amount. The important points to remember are that: 1) You can't separate the effect of years of service as opposed to benefit on earnings in this analysis. 2) Not having years of service in the regression does not necessarily bias the results, because information about years of service is embedded in the variable for benefit, with little additional random effects after controlling for final compensation. It would be better, however, if the retirement system were to include the actual measure of years of service in the model. The difference between my proxy variable and actual years of service would come from individuals who retired with reduced benefits.

In the spirit of making a useful contribution to the retirement system's ongoing policy process for this subject, I include all software code I used to get these results in an appendix. If the retirement system added years of service to its dataset, or any other variables, it could re-run the analysis without too much effort.

### *Results: Earnings in Retirement*

My results suggest that, on average, retirees were willing to work for a little less the more they received in benefits, controlling for compensation at retirement and other factors. Again, you could interpret that to mean retirees with more years of service were willing to work for less in

retirement. See the note above. However, in one of the two final models I found the opposite relationship for retirees who returned to work in public schools.

Controlling for the other factors in the model, I estimated:

- Retirees who work for their former systems while continuing to earn their benefits do seem willing to work for less, as their benefits get larger.
- For example: A 1-percent increase in weekly benefit amount at return to work was related to an 0.08 percent decrease in earnings during retirement, for non-school, non-exempt retirees with average fitted values and average benefit amounts. Again, that holds constant a person's pre-retirement compensation.
- Retirees with higher pre-retirement compensation I estimated to have higher earnings when they returned to work, holding constant all other factors, which makes sense.
- For non-exempt school employees, I estimated the relationship between earnings and benefit amount to be positive in one model. See below for details.
- In the model that allowed the effect of benefit amount on earnings to be different depending on the size of the benefit, the effect grew stronger for retirees with larger benefits.

I report estimated effects of retirement benefit amount on earnings in terms of elasticities: The percent change in the dependent variable you would expect to see from a one-percent change in the benefit amount at return to work, controlling for all other factors in the model. Since I am ultimately interested in earnings, not its logarithm, I first transform to logged dependent variable into its fitted un-logged form. See appendix two for details. In the paragraphs below I call unlogged earnings the "fitted value".

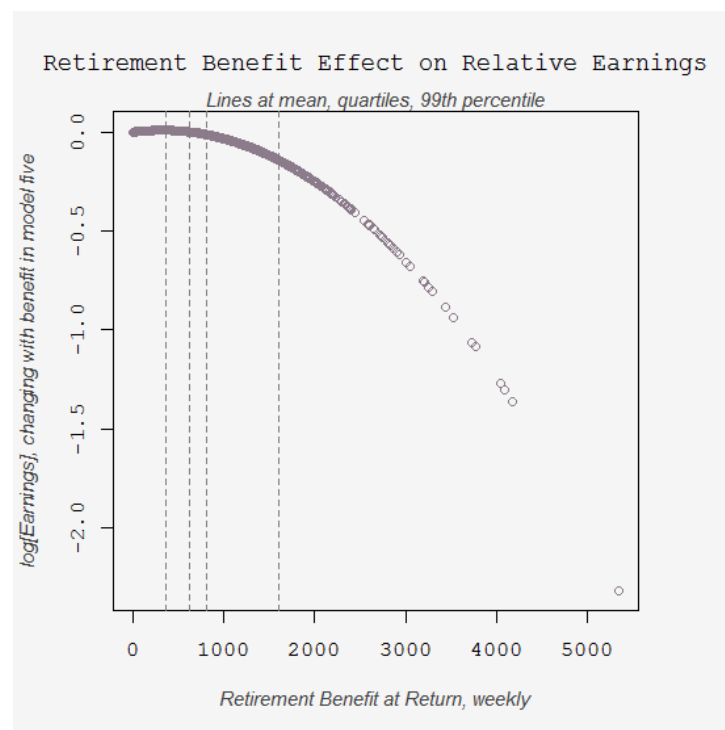
Results below come from two models. In model five, I included benefit amount as a squared variable, in model one I did not. Including benefit as a quadratic function allows the change in earnings from a unit change in benefit amount to be different depending on how much a person makes. I included both results because both made it through the series of criteria I set up to evaluate the models. The two models both estimate that earnings in retirement decrease as retirement benefit increases for non-school, non-exempt retirees. The models differ in their estimated effects for retirees who fall into those groups. It made no sense to evaluate earnings for retirees who were exempt from the earnings limit but did not work in schools, since only a handful fell into that category.

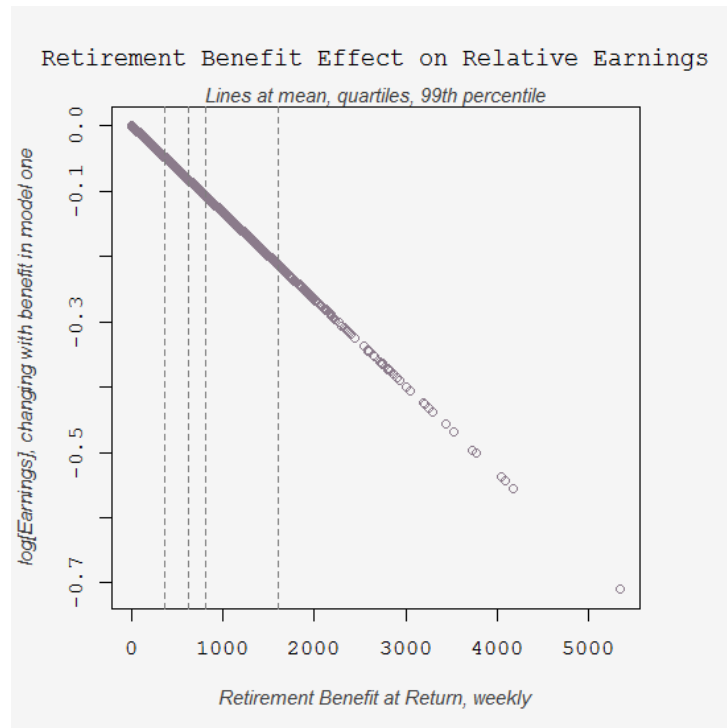
The table below reports elasticities from models one and five. Since both models included interaction terms with 0-1 indicator variables for retirees working in schools, the effect of benefit on earnings changes depending on whether a retiree fits in that group.

	Non-School, non-exempt				School, non-exempt	School and exempt
Model	Means	25th pctl	75th pctl	99th pctl	Means	Means
Linear (1)	-0.08152	NA	NA	NA	-0.08078	-0.08222
Quadratic (5)	-0.03301	-0.00247	-0.07231	-0.38146	0.040773	0.030832

Full regression results for both models are in appendix one. The important difference between the models is that model one has no exponential variables: The relationship is a straight line. Model five has benefit amount included as a quadratic. See the second part of this paper for details.

Model one in the first graph instead shows a slightly downward sloping line. Model two in the second graph illustrates how the quadratic model characterizes the relationship between benefit amount and earnings in retirement. Note that the graphs do not give the same numbers as the ones in the table above. The table above gives percent changes for percent changes. The graphs below give the expected unit change in logged earnings for a unit change in benefit. I include the show graphically how the two things are related in the models.





### *Implications: Earnings in Retirement*

As I said above, one of the most common policy options to offset costs related to easing work restrictions for retirees is to impose a surcharge for employers on the value of a retiree's earnings. These results suggest such a policy could be workable for retirees with larger benefit amounts. The results also suggest it might be worth considering valuing the surcharge based on a worker's retirement benefit, as opposed their earnings. Rehired retirees with larger benefits would ultimately earn less under that kind of policy, since employers likely would incorporate the cost of the surcharge into the wages they offer. But if they are willing to work for less, retirees might not be turned off by the lower wages.

One of my estimates suggests there is the opposite effect for retirees who worked in schools. For those employees, one model estimated earnings in retirement increased as benefits increased. An explanation might be that teachers with long experience could be in high demand, allowing them to command higher wages when they return to work.

### *Limitations: Earnings in Retirement*

This is not a prediction of what could happen after a particular policy change. For example, if there were large numbers of retirees who decided not to return to work for public employers because of restrictions on how much they can earn or how many hours they can work, results above probably would not hold after those restrictions were lifted. That doesn't have to be the case, though. Most



people in the sample had earnings well below the limit, which could mean retirees are only interested in earning and working a little in retirement anyway. As a result, their behavior might not change much from what it has been over the past five years if the policy were to change. In that case, the relationships between earnings and benefit amount could stay more or less the same.

I should also be clear that my data do not include information on retirees who retire then leave retirement, and stop receiving retirement benefits, to become full-time employees and contributing members of the system. Data also do not include retirees who continue receiving retirement benefits but work in any capacity for private employers. Therefore I can make no inferences about retirees who return to work in general.

I also do not try to predict how much retirees will earn when they return to work, even if circumstances do not change. Prediction is a slightly different kind of analysis and has a different process with different criteria. Variances for the predicted values are different from the variances in the estimated effects. Prediction also comes with more uncertainty, particularly if you are trying to predict what might happen after a policy change that has never before happened. Still, in the case of linear regression, the process I used and a predictive analysis would be similar. For example, the estimated coefficients from this model together with the data could create the so-called best linear unbiased predictor of the dependent variable.<sup>3</sup>

### *Results: Length of time in work*

Full results tables are in appendix one. The intuitive interpretation of the results is in terms of acceleration factors – the proportion by which retirees’ expected probability of working a certain amount of time grows or shrinks based on their characteristics. If a variable’s acceleration factor is greater than one, the length of time a person works is estimated to increase when that variable increases. If the factor is less than one, the length of time a person works is estimated to decrease.<sup>4</sup>

Estimated acceleration factors are below, where the “+ #” terms show the increase in the dependent variable used to calculate the acceleration factor. The bullet points following the chart explain the variables, and the academic brief has more information.

For example, you would read the table to mean that an increase of \$10 billion<sup>5</sup> in private-sector state economic output in the year a person returns to work is estimated to reduce the time a person is expected by a factor of 0.73. So if a person had a 50-50 chance of working one year before quitting, that person is estimated to have a 50-50 chance of working about three-quarters of a year before quitting when economic output is \$10 billion higher.

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<sup>3</sup> Amemiya, T, *Advanced Econometrics*, 1985, p 39

<sup>4</sup> Kleinbaum and Klein, p 298

<sup>5</sup> In constant, 2013 dollars. See the description of variables in the academic brief.

Variable	Acceleration Factor Estimate
<b>ln_diff +0.22</b>	1.013889585
<b>school</b>	2.431862558
<b>tsers</b>	0.437434483
<b>unc</b>	2.60429882
<b>comcol</b>	2.415769925
<b>sp500.lag1 +10</b>	0.986351574
<b>priv_gsp.B +10 <sup>6</sup></b>	0.725654147
<b>gov_gsp.B +10 <sup>7</sup></b>	1.200688737
<b>rtwlag + 1yr</b>	0.99530679
<b>post09_rtwbegin <sup>8</sup></b>	0.575566766
<b>socsec_any</b>	0.843742198

I did not include factors for coefficients that were not significantly different from zero. See appendix one for the full results.

The results make common sense, and I interpret them this way:

- A larger ratio of earnings in retirement to compensation before retirement (ln\_diff)<sup>9</sup> extends the time a person works in retirement, controlling for the other factors.
- Retirees who worked in schools could be expected to work two and a half times longer than those who did not work in schools. Working at a university or community college had a similar effect.
- Retirees from TSERS who were not university (unc), school, or community college (comcol) employees could be expected to work only half the time an LGERS retiree works.
- More economic activity in the private sector is related to shorter work times. One explanation might be that retirees or their spouses are able to find better-paying work in the private sector when private sector output is higher, pulling them away from work for public employees.
- Retirees who started working Jan. 1, 2010 or later could be expected to work just about half the time of employees who started working before then, all else equal. That effect is estimated while controlling for the fact that some retirees before 2010 were exempt from the earnings limit.
- Being eligible for social security benefits (socsec\_any) also shortened the time a retiree might be expected to work, though since age itself is not controlled for in this model it's unclear whether that effect is because of age or because of social security benefits themselves.

<sup>6</sup> Private-sector gross state product at year of return to work in billions of 2013 dollars

<sup>7</sup> Government-sector gross state product at year of return to work in billions of 2013 dollars

<sup>8</sup> 0-1 indicator equal to one if a person returned to work Jan. 1, 2010 or later. Effect is for those with the indicator equal to one.

<sup>9</sup> The variable is the natural log of the ratio, but an increase in the log means an increase in the unlogged ratio.

*Limitations: Earnings in retirement*

Important tests of the survival analysis assumptions fail for the small group of retirees who work for less than a month or so. See the academic brief for more detail on that important limitation. So the results probably do not do a good job describing factors influencing how long those individuals work in retirement. The same is true for school employees who were exempt from the earnings limit. Therefore I do not include an acceleration factor for that group in the results above.

The question is whether those aberrations bias the results for other groups. I re-estimated the model twice, once without retirees who were exempt from the earnings and limit and who were not school employees, and again without retirees who worked less than a month before quitting. Neither changed the results of my final model much, as shown in the tables in the second appendix.

## PART TWO: ACADEMIC BRIEF

### Background

#### Returning to Work After Retirement

Recent polls and demographic trends show retirees are living longer, working longer and retiring later than they did decades ago. Life expectancy at birth increased 13 percent - 69.7 years to 78.7 years - from 1960 to 2010.<sup>10</sup> Life expectancy at age 65 increased 34 percent in that time, from 14.3 years to 19.1 years.<sup>11</sup> Such demographic changes have broad implications for retirement policy.

According to Gallup polls, the expected retirement ages among active workers in 2012 was 67 years, on average, compared to an expected retirement age of 60 years in 1996.<sup>12</sup> Separate Gallup polls showed respondents reported actual average retirement age of 61 years in 2013, compared to an average retirement age of 57 years in 1991.<sup>13</sup> Retirement ages in TSERS have followed a similar trend, with the average retirement age reaching 62 in 2012.<sup>14</sup>

Perhaps as a result of those demographic changes, reentering the workforce after retirement is common. One study estimated that about 60 percent of older workers from 1992-2002 left full-time jobs for less-than-full-time jobs, so-called "bridge jobs," before leaving the labor market.<sup>15</sup> A study published in the Bureau of Labor Statistics Monthly Review found that roughly 15 percent of Americans who left the workforce came back to work after four or more years.<sup>16</sup> Older workers' fluid approach to retirement sometimes clashes with pension plan policies, which are designed to secure income for workers who leave the labor force altogether.<sup>17</sup>

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<sup>10</sup> Life expectancy at birth, at age 65, and at age 75, by sex, race, and Hispanic origin: United States, selected years 1900-2010, Centers for Disease Control and Prevention

<sup>11</sup> Ibid

<sup>12</sup> Expected Retirement Age in U.S. up to 67, Gallup, <http://www.gallup.com/poll/154178/expected-retirement-age.aspx>, retrieved May 23, 2013

<sup>13</sup> In U.S., Average Retirement Age up to 61, Gallup, <http://www.gallup.com/poll/162560/average-retirement-age.aspx>, retrieved Oct. 31, 2013

<sup>14</sup> Retirement Security for N.C. Teachers and State Employees, Presentation, N.C. Department of State Treasurer, May 6, 2013

<sup>15</sup> Cahill, Geandria, and Quinn, "Retirement Patters from Career Employment," The Gerontologist, April 2006. <http://gerontologist.oxfordjournals.org/content/46/4/514.full>

<sup>16</sup> Cahill, Giandrea, and Quinn, "Reentering the Labor Force After Retirement," Monthly Labor Review, Bureau of Labor Statistics, June 2011. <http://blsweb1.psb.bls.gov/opub/mlr/2011/06/art2full.pdf>

<sup>17</sup> C.F.R. § 1.401(a)-1(b)(1), "In order for a pension plan to be a qualified plan under section 401(a), the plan must be established and maintained by an employer primarily to provide systematically for the payment of definitely determinable benefits to its employees over a period of years, usually for life, after retirement or attainment of normal retirement age."

## Defined-Benefit Pension Plans

Defined-benefit pension plans offer plan members a monthly benefit after retirement. Benefit amounts typically are defined using a formula based on years of service with an employer in the plan and on salary earned leading up to retirement.<sup>18</sup>

Participants in defined-benefit pension plans make tax-free contributions toward retirement, as do their employers.<sup>19</sup> Investment earnings for pension plan trusts are also untaxed. To qualify for special tax treatment, pension plans must qualify under Internal Revenue Code Section 401(a) and all related Internal Revenue Service laws and rules.

## Policies to Restrict Work During Retirement

To meet federal and state requirements, defined-benefit pension plans place a number of restrictions on reemployment for retirees receiving pension checks. Restrictions typically include limits on earnings and full-time employment, as well as a requirement to wait a period of time before becoming reemployed. Typically, restrictions only apply to work with an employer participating in the same retirement system from which the retiree is receiving benefits. For example, a retiree from TSERS who returned to work for a state agency would be subject to an earnings restriction. If the retirees had returned to work for a private-sector employer, the earnings limitation might apply if the person were to work directly for the state agency through a third-party contract. But in most cases the earnings limitation would not apply to a retiree working for an employer that does not participate in TSERS.

Policies to restrict employment for retirees with pension benefits exist for two reasons:

1. Internal Revenue Service laws, regulations and rulings require retirement systems qualified under Internal Revenue Code Section 401(a) to distribute retirement benefits only after a retiree has separated from service or after the retiree has reached normal retirement age.<sup>20</sup>
2. Retirement systems lose a source of revenue when retirees receiving a pension benefits take the places of non-retired employees who would have contributed to the system. To limit losses to retirement funds, some systems require employers or rehired retirees or both to contribute to the system while the retirees are employed.

Consequences are potentially severe for a retirement system that fails to follow IRS requirements under IRC Section 401(a). Disqualified plan trusts, employers and employees lose all tax-preferred

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<sup>18</sup> Definitions, Internal Revenue Service, <http://www.irs.gov/Retirement-Plans/Plan-Participant.-Employee/Definitions>, retrieved 10/31/13

<sup>19</sup> Retirement Topics - Contributions, Internal Revenue Service, <http://www.irs.gov/Retirement-Plans/Plan-Participant.-Employee/Retirement-Topics-Contributions>, retrieved 10/31/13

<sup>20</sup> C.F.R. § 1.401(a)-1(b); Revenue Ruling 56-693, 1956-2 C.B. 282, as modified by Revenue Ruling 60-323, 1960-2 C.B. 148; Letter to N.C. Retirement Systems Director Discussing General Requirements Regarding Distributions from a Qualified Benefit Plan, Schmieder, D., Buck Consultants, 2001

treatment, and the IRS could assess penalties to a plan worth as much as the total foregone tax liability for contributions and earnings.<sup>21 22</sup>

Consequences for retirees who violate return-to-work policies are also harsh. Typically, pension plans recoup all or part of retirement benefits paid after the date at which payments should have stopped because of a return-to-work violation. State employee defined-benefit pension systems interpret IRS requirements differently and have developed varied approaches to regulating reemployment for retirees.

### **Retirement and Return-to-Work Policies in TSERS**

None of North Carolina's defined-benefit retirement plans has a normal retirement age, and most do not allow for the distribution of retirement benefits before a separation from service. The phased retirement program for public university employees is the one exception.

To receive full retirement benefits, TSERS members must have at least 30 years of service as state employees, implying a minimum possible retirement age of 48 years.<sup>23</sup> In 1973, the state legislature removed a minimum retirement age for TSERS of 62 and replaced it with the current 30-years-of-service requirement.<sup>24</sup>

Once retired, members are subject to three policies restricting work during retirement:

- Retirees are not to perform any type of service, including volunteer or contract service, for an employer within TSERS for six months after the effective date of retirement.<sup>25</sup> That policy exists in part to meet the IRS requirement to ensure a separation of service between employer and employee before distributing retirement benefits. The IRS has not defined how long the separation period must be or what types of service constitute violations of the separation of service requirement.
- Retirees receiving pension benefits cannot hold positions eligible to participate in and make contributions to the retirement systems, also called covered employment. For a position to qualify for membership in TSERS, the position must require at least 30 hours per week for at least nine months per year.
- Retirees working for an employer participating in TSERS, including on a contractual basis, must earn less than a specified amount. The annual earnings limit is the larger of: 1) 50 percent of the retirees last 12 months' of compensation before retirement, or 2) \$30,160 in 2012, which is adjusted using the Consumer Price Index each year. If a retiree exceeds the limit, his or her retirement benefits are suspended for the rest of the calendar year.

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<sup>21</sup> Tax Consequences of Plan Disqualification, Internal Revenue Service, <http://www.irs.gov/Retirement-Plans/Tax-Consequences-of-Plan-Disqualification>, retrieved Oct. 31, 2013

<sup>22</sup> Section 5.01(5), Internal Revenue Bulletin 2013-4, Internal Revenue Service, Jan. 22, 2013

<sup>23</sup> N.C.G.S. § 135-5(a)

<sup>24</sup> Retirement Security for N.C. Teachers and State Employees

<sup>25</sup> N.C.G.S. § 135-1(20)

Return-to-work law has become a prominent issue for the North Carolina Retirement Systems Division, which administers all of the state's public employee pension plans. Several high-profile cases have raised the issue and caused retirement system leaders to contemplate reforms.

For example, in one case the client's staff often cites, a recently retired school bus driver was asked to return tens of thousands of dollars in pension payments because he had substituted for another bus driver in an emergency. He did so during the separation of service period after retirement, when he was not allowed to perform any services for an employer participating in the retirement system. Such cases not only create public relations problems for the retirement system but also tend to inspire litigation that is costly for the system to defend against.

Modifying return-to-work laws holds implications for state human resource capacity, for retirement system finances, and for retirees and employers in the retirement systems, which are important constituent groups for the retirement systems' leaders.

### **Normal Retirement Age and In-Service Distributions**

IRS laws and regulations state that a plan may distribute benefits while a person is still employed, without a separation of service, if:

- the beneficiary has attained normal retirement age,<sup>26</sup>
- or the beneficiary is at least 62 years old.<sup>27</sup>

As a result, establishing a normal retirement age relieves pension plans of the need for reemployment and separation of service policies to ensure compliance with § 401(a). A plan still might maintain reemployment restrictions to prevent rehired retirees from taking the places of employees who could contribute, rather than withdraw, funds to the retirement system. Normal retirement ages are not by definition the same as minimum retirement ages. Some states, for example, allow employees to retire earlier and to receive reduced retirement benefits.

If a pension plan does establish a normal retirement age, it "must be an age that is not earlier than the earliest age that is reasonably representative of the typical retirement age for the industry in which the covered workforce is employed."<sup>28</sup>

Plans establish their own normal retirement ages, within IRS guidelines. A normal retirement age of 62 years or later is considered to be in compliance. An age between 55 years and 62 years might be compliant depending on the facts and circumstances. Normal retirement ages of less than 55 years are not in compliance. However, normal retirement ages of 50 years or more are compliant for plans in which substantially all participants are qualified public safety employees under 26 U.S.C. § 72(t)(10)(B).<sup>29</sup>

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<sup>26</sup> C.F.R. § 1.401(a)-1(b)(1)

<sup>27</sup> 26 U.S.C. § 401(a)(36)

<sup>28</sup> C.F.R. § 1.401(a)-1(b)(2)

<sup>29</sup> C.F.R. § 1.401(a)-1(b), also called the 2007 NRA regulations

The IRS in 2012 said it intends to revise those rules as applied to governmental plans, such as TSERS, to clarify that governmental plans can but do not have to set normal retirement ages in most cases, so long as they do not provide in-service distributions before age 62.<sup>30</sup>

## **Peer-State Policies**

State policies for retirement ages and retiree reemployment vary significantly in their details, but most have two basic components: A minimum age at which a person can retire with full pension benefits, and a requirement to have been employed within the pension system for a minimum number of years before receiving a full pension benefit. Policies often blend those two components, setting different requirements for years of service based on a person's age.

59 percent of statewide defined-benefit pension plans open to enrollment set minimum age requirements for retirement. 41 percent of them allow retirement at any age after 30 years of service, as TSERS does, or after a greater level of service.<sup>31</sup>

Only one of North Carolina's peer systems placed a limit on earnings of rehired retirees, as of fall 2013.<sup>32</sup> The Michigan Public School Employees Retirement System has an earnings limit of one third of the final average compensation for retirees of who return to work directly for or as a contractor in a Michigan public school. Retirees who go over the limit forfeit retirement benefits and health plan premiums until employment ceases. A law passed in 2010 removed the previous limit of one third of final average compensation or the Social Security earnings limit, whichever was greater.<sup>33</sup>

## **Value of this project for return-to-work issues in North Carolina**

As the state's human resources evolve, the North Carolina retirement systems could consider a number of policy changes related to retirees who return to work. Among the most significant changes could be to impose a normal retirement age, after which a person could begin to receive benefits and could work with minimal restriction, while continuing to receive a retirement check. The policy would obviate at least two of the three restrictions on working in retirement. Separation of service and reemployment policies become irrelevant when no one can retire before a certain age, at which they can continue to work while receiving benefits.

I am not trying to estimate the long-term costs and benefits of a particular policy change to the retirement system, which the system's actuaries do. Instead, the goal of this project is to give the retirement system a better understanding of what factors affect how long retirees come back to work for public employers, and how much they earn in doing so.

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<sup>30</sup> Notice 2012-29, Internal Revenue Service, April 30, 2012

<sup>31</sup> Fiscal Integrity H 381 Policy Brief, N.C. Retirement Systems Division, May 28, 2013

<sup>32</sup> I considered other systems to be peers if a state's total pension liabilities were funded at 70 percent or more, and if actuarial accrued liabilities were between \$30 billion and roughly \$80 billion, as of 2011. The metrics include all pension funds within the state. Those measures for North Carolina are 95.3 percent and \$60.9 billion. Within a state, the primary systems were chosen to be peer systems. Reference for funding figures: "The State of State Pension Plans," Morningstar, November 25, 2012

<sup>33</sup> "Working After you Retire," Michigan Office of Retirement Services, [http://www.michigan.gov/orsschools/0,4653,7-206-36502\\_36516---,00.html](http://www.michigan.gov/orsschools/0,4653,7-206-36502_36516---,00.html)



That information could help the retirement system assess the implications of a change in return to work policy for state human resources and for different groups of retirees. For example, if the state were to create a policy in which individuals can work for the state without restriction, retirees who work for longer and earn more could stand to benefit the most or at least be more sympathetic to a policy that allows them to avoid the hassle of restrictions. In addition, if certain retirees are willing to work for less than others, state agencies might be willing to pay a portion of retiree earnings to the system to offset the actuarial cost the retirement system bears when a retiree takes the place of an active employee.

It is difficult to say how retirees' behaviors might change under different circumstances and whether they would work more if allowed or work less if required to wait until reaching normal retirement age to retire in the first place. Still, a model that properly describes factors affecting retirees' earnings and length of work in retirement has value, if for no other reason than to help the retirement system better understand that population.

## Data on public employee retirees who return to work in North Carolina

### The dataset and data cleaning

The dataset began with 29,069 observations, each representing a retiree of the LGERS or TSERS who returned to work for the same system from which the person retired, while continuing to receive a benefit. The data spanned from January 1, 2003 to December 31, 2013. To distinguish working retirees from active employees, the retirement system uses three codes: STRE, STRS and LOCRS. The first is for retirees exempt from the earnings limit and applies to only one individual in the dataset after 2010. LOCRS and STRS marks members subject to the earnings limit for retirees who return to work and continue to receive their benefits.<sup>34</sup> Employers report individuals who return to work subject while continuing to receive benefits. Earnings reported for individuals receiving benefits but not categorized as LOCRS, STRS or STRE are flagged automatically in Orbit and corrected. It is possible that some employers fail to report retirees earning pay.

I removed 3,179 observations with dates of return to work prior to Jan. 1, 2007. Data from those years were unreliable, since they pre-date the retirement system's data management software, Orbit. The data were erratic, with several hundred observations marked as beginning work at the same time but no observations beginning work for long stretches. I removed an additional:

- 357 observations with no benefit amounts at the time of their return to work – clear errors because no person who is retired can have a benefit of zero. All of those

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<sup>34</sup> Teachers, under certain conditions, were exempt from the earnings limit. That exemption expired Oct. 1, 2009. The 2009 North Carolina General Assembly created a new exemption for certain nursing instructors in TSERS. That exemption expired in 2013. Source: "Significant Events Concerning the North Carolina Teachers' and State Employees' Retirement System," North Carolina Retirement Systems Division

individuals also had missing values for system type, employer type, and average final compensation.

- 19 observations with negative values for length of time working in retirement or length of time from retirement to return to work.
- 275 observations with average final compensation of zero, again clear errors because no person eligible for a retirement benefit can have final compensation of zero.
- 259 additional observations with no earnings in any of the years. Since the code to generate the dataset was intended to capture individuals earning pay, those are likely errors.

That left 24,980 observations in the analysis.

The data do not include those who returned to work as full-time employees, and stopped receiving their benefits, or those who went to work for private employers and therefore were not subject to return-to-work laws. Having data on those individuals would allow for a model that estimates factors affecting the decision to return to work, when and where. Without those data, the models in this paper can only try to describe which factors influence how long people work in retirement and how much they earn from it, given that they chose to return to work for the state and to continue receiving their benefits.

## **Dependent variables**

### *Earnings in retirement*

For the earnings analysis, I added annual earnings across a person's entire period of work in retirement, after adjusting all figures to 2013 dollars using the U.S. GDP price deflator. I then calculated a person's average weekly earnings for the period in which they worked.

### *Length of work in retirement*

My dependent variable here was the number of weeks between the first day of the first pay period of work in retirement, and the last day of the last pay period of work in retirement. I used weeks because they are a precise measure, whereas months or years vary in length. A clear issue with the dependent variable is that the data are not able to distinguish between multiple starts and stops of work within a period and one continuous period of work. Because I provide the code for this analysis, the retirement system could re-run the analysis if its data are able to make that distinction.

The issue is not as serious as it might seem at first. Median length of work time in retirement was one and three-quarter years, a relatively short period. You might expect that time to be longer if many people were returning for a short period early on and another short period later in the analysis timeframe. Also, individuals who returned for different work periods under different classification codes – such as STRS and STRE – were marked separately, as were individuals who returned to work for different employers. That figure, *nrtw* in the list below, was included in the analyses as a control.

As a result, this analysis only makes inferences about the total length of time between when someone was first marked as earning pay as a retiree and the last pay period in retirement. I suggest the retirement system re-run the analysis once the data improve and have provided the code to do so.

Survival analysis measure the time until a specific event, in this case the end of the work period. Those who had not finished working as of Jan. 1, 2014 were counted as censored observations, meaning they were counted as not having stopped working.

## Explanatory variables

Explanatory variables were taken from the list below. In general, I tried to use as many explanatory variables as possible, avoiding any clear statistical issues of perfect collinearity – when two variables are perfectly correlated. For example, you would not include indicator variables for each of the retirement system codes and would instead include only two of them, with the variable left out represented in the model's constant term.

Variables in the dataset	Variable name	Description
Arbitrary observation identifier	i	
Age at return to work	age_rtwbegin	in years
Retirement system plan code	tsers, lgers, or stre	STRE, STRS and LOCRS as described above
No. days before return	rtwlag	Return to work begin date minus retirement date
Agency code		employer code of agency where employed in retirement
Average final compensation	afc.weekly	the average annual compensation, in 2013 dollars <sup>35</sup> , in the four years before retirement, defined in N.C.G.S. 135.1(5) . Divided by 52.17 to give a weekly figure.
Earnings/AFC	ln_diff	Log(average weekly earnings in retirement / afc.weekly)
SP500 Index	sp500.lag1	Average S&P 500 stock index, average from the year prior to return to work
Governmental gross state product	gov_gsp.B	Governmental gross state product in North Carolina, from the year of return to work. In billions of 2013 dollars.
Private-sector gross state product	priv_gsp.B	Private-sector gross state product in North Carolina, from the year of return to work. In billions of 2013 dollars.
Weekly retirement benefit	ben_rtw.weekly	monthly benefit amount, in 2013 dollars, at return to work, converted to weekly amount dividing by (30.5/7)
Squared weekly benefit	quad.ben_rtw.weekly	equal to 0.0001 times ben_rtw.weekly squared. I scaled it down just to avoid lots of zeros in the coefficients.
Social Security eligible	socsec_any	Age 62 or older at return to work, the earliest age at which a person can receive Social Security retirement benefits <sup>36</sup>
Medicare eligible	medicare	Age 65 or older at return to work, the Medicare eligibility standard age
Log of monthly benefit	ln_realbenefit	natural log of monthly benefit amount
School employee	school	indicator variable marking whether a person returned to work for a public school

<sup>35</sup> All dollar figures from past years were adjusted for general price inflation using the U.S. G.D.P deflator published by the St. Louis Federal Reserve Board. The deflator is not adjusted for seasonal differences.

<sup>36</sup> Social Security Administration, <http://www.ssa.gov/retire2/retirechart.htm>, accessed April 1, 2014

<b>School employee exempt from earnings limit</b>	school.stre	indicator variable marking those who worked for public schools and were exempt from the earnings limit. All but a few of the exempt employees worked in schools, so this indicator allows for comparison of school employees with and without the earnings limit.
<b>UNC employee</b>	unc	indicator variable for retirees working for the University of North Carolina and its institutions
<b>Community College employee</b>	commcoll	same, but for the state community college system
<b>Post-2009 Begin</b>	post09_rtwbegin	Indicator = 1 for individuals who began work Jan. 1, 2010 or later. Intended to capture effects of the recession on earnings.
<b>Nth tour as a return to work retiree</b>	nrtw	marks the nth time a person has returned to work for the state, for individuals who changed classes or employers. Used as a control only.
<b>Active as of Jan. 1, 2014</b>	active	indicator marking those who had no end date as of Jan. 1, 2014

## Graphs and distributions of key data

Density charts, histograms and other graphs below describe a few important variables in the data. Density charts and histograms show how common a certain value is in the data, with the highest point being the most common.

### *Age at Beginning and End of Work in Retirement*

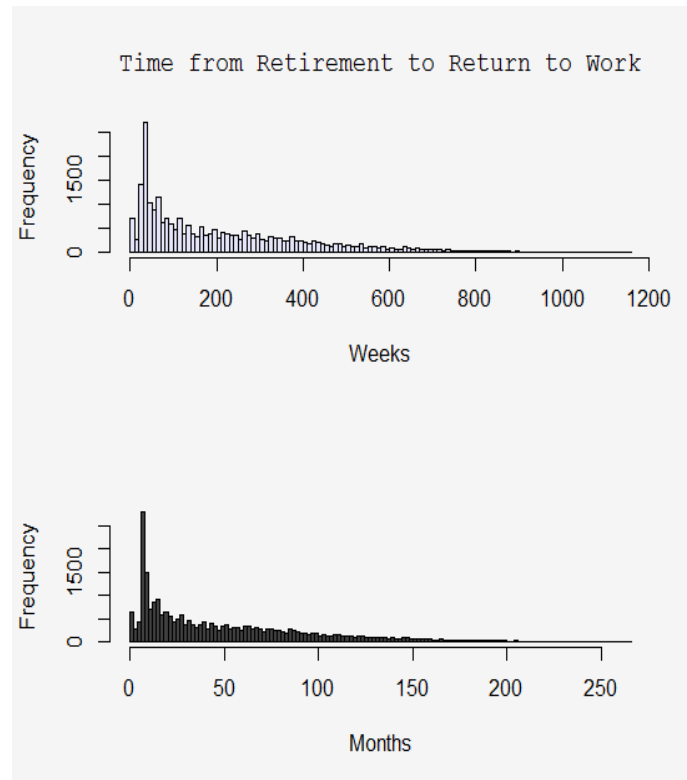
This graph shows that retirees who come back to work are not concentrated in one age range or another. Their ages are basically symmetric and centered around the average age of retirement -- 62 years -- for North Carolina's Teachers' and State Employees' Retirement System.



### *Time Between Retirement and Return to Work*

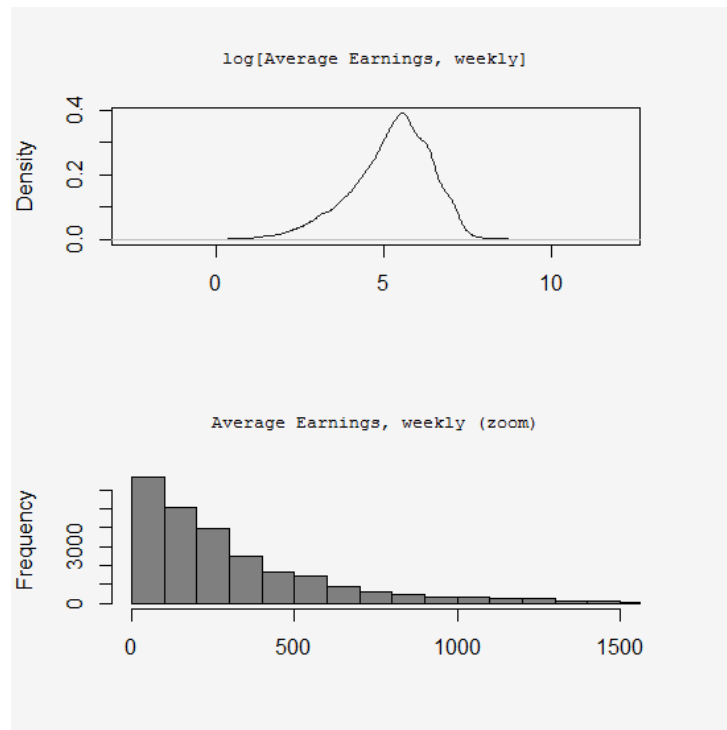
Since state law restricts how soon retirees can return to work, you might expect a sudden spike in the number of people returning to work when the required waiting period has ended. Local system retirees must wait one month before returning, and state system retirees are required to wait six months.

The graphs below do show a spike, particularly at the 7month mark, since most retirees in the dataset are from the state system. But the graphs also clearly show a steady trickle of retirees who return to work after waiting longer periods than required.



### *Earnings in Retirement*

Graphs below show two forms of the dependent variable, average weekly earnings in retirement and its natural logarithm. Economists often use natural logarithms of wages for regression analysis of earnings. Doing so reduces the effect of outliers and usually makes earnings have a distribution that is closer to the normal distribution, a bell-shaped curve.<sup>37</sup>



### *Earnings in Retirement over Benefit*

The graphs below are plots of the key dependent variable, the log of average weekly earnings, over the key explanatory variable, weekly retirement benefits when the retiree returns to work. Different panes show that plot for different groups of individuals. For example, the first graph's right-hand pane shows earnings plotted against benefit for retirees who returned to work for schools.

The second graph with reddish dots shows the same information, but the variable along the x-axis is the squared benefit amount, as described in the table above. In both graphs, a few outliers with large benefit amounts are out of the picture.

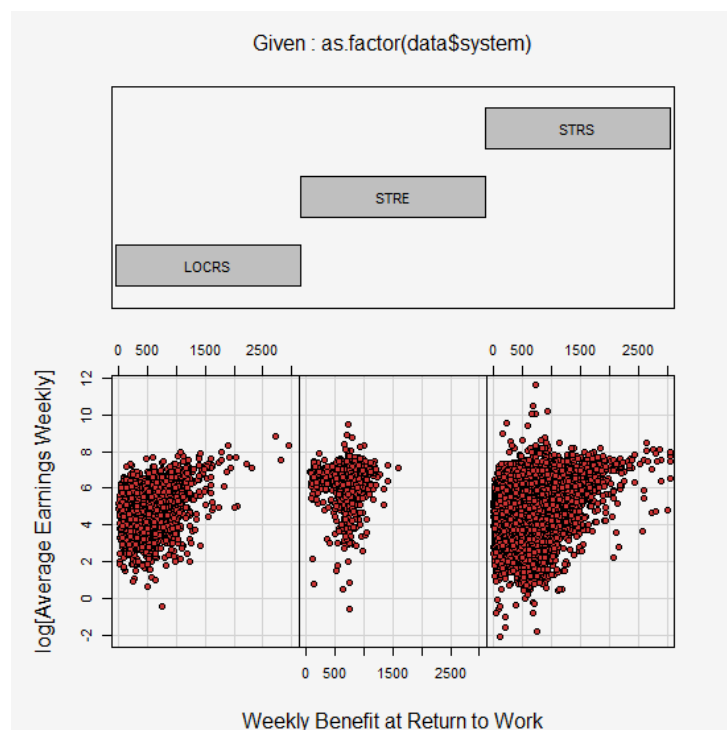
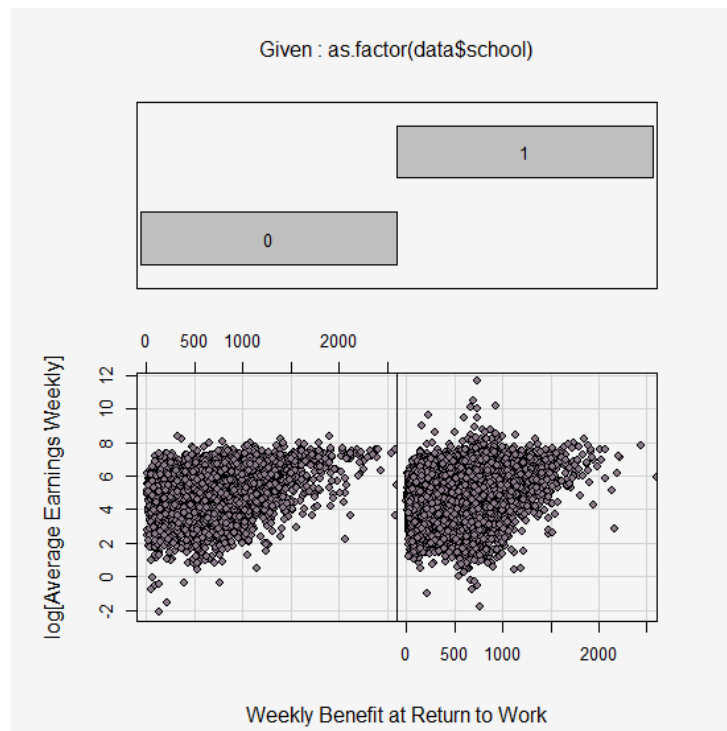
A few observations about the graphs:

- The log of earnings increases as benefit increases, which means earnings do too. The relationship between earnings and benefit looks more or less linear.

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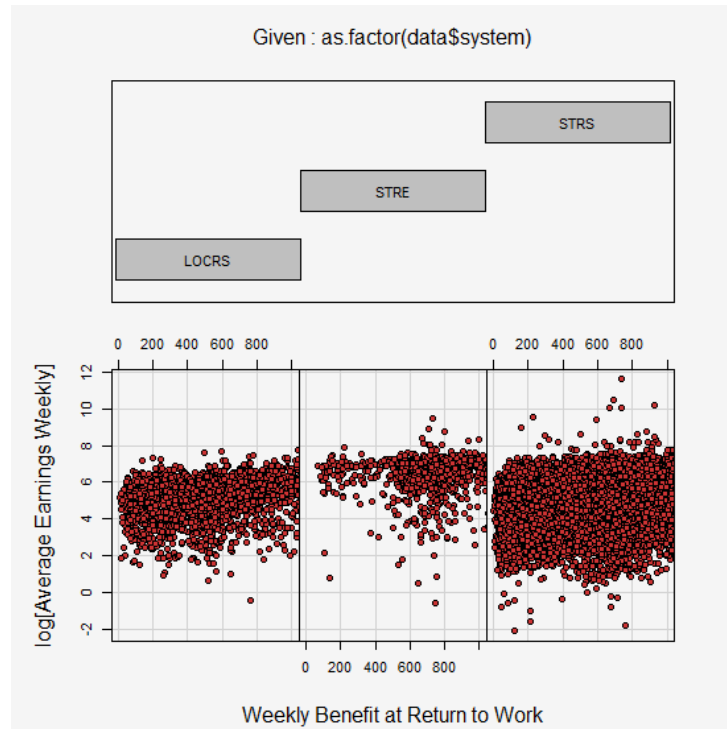
<sup>37</sup> Wooldridge, p 238

- There is a slight curvature at the bottom end of wages even when retirement benefits are not squared, which suggests maybe a quadratic form of the model is worth considering to allow for a u-shaped relationship.





A zoomed-in version of the previous graph:



### *Length of Work Period in Retirement*

Most retirees work short periods in retirement, less than two years. The length of time retirees work steadily declines, as you might expect. That will be important in the survival analysis because it suggests that the probability a person will stop working in a given week increases with time: The longer you work, the more likely you are to quit. One of the models does not allow for that kind of trend, while others do. The spike near the end of the distribution comes from the fact that individuals who worked the entire period without quitting were given lengths at the maximum amount possible, the entire period from Jan. 1, 2007 to Dec. 31, 2013.



## Earnings in Retirement

Least-squares regression analysis is the most plain regression model used in economics and statistics. It calculates a straight line relating the characteristics of the observations with the dependent variable, in a way that minimizes the sum of the squared differences between the observed values of the dependent variable and the model-fitted values. Least-squares regression is often used to model earnings as a function of a person's attributes, and that is what I do here.

### Model Assumptions

I rely on the fact that my sample size is large, at 24,980, to use the large-sample properties of least-squares analysis. With large sample sizes, criteria for when least-squares analysis will give good estimates of the relationships between the dependent and explanatory variables are that:<sup>38</sup>

1. The true relationship between the dependent variable and the explanatory variables is linear. That means values of the dependent variable are the sums of explanatory variables times some multiplicative factor, called a coefficient. If you were to graph that relationship, it would give a straight line. A linear relationship does not rule out either type of variable taking an exponential form, and often the relationship between the variables becomes more linear when one is a logarithm or a power of the original variable.

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<sup>38</sup> I put these criteria in roughly general terms for the sake of making them understandable. For exact definitions of the criteria, see appendix two and Hayash , p 109. Hayashi was the main reference for these criteria.

2. The data are a random sample of the population. The population in this project is the group of retirees who returned to work, while continuing to receive retirement benefits, for employers in the system from which they retired. The dataset essentially represents the population itself and so meets this criterion. The dataset likely would not be a random sample of all public retirees in North Carolina because it includes only those who chose to come back to work for the state. Those people might be different than retirees who choose not to work, and so I do not try to make inferences about retiree work habits at large. See appendix two for more information on this criterion, which is more complicated than it seems.
3. The expected values of the error terms and each of the explanatory variables is zero. This assumption is sometimes described as the orthogonality assumption. See appendix two.
4. The expected value  $E(xx')$  is nonsingular. That just means two columns of explanatory variables cannot perfectly predict each other. “x” here refers to a vector with one person’s attributes. This criterion would be violated if the regression included 0-1 indicator variables for each of the three retirement types. Since a person must have one of the retirement class types, knowing two of them means you can perfectly predict the value of the other. That is why the regressions below, and the survival regressions, always leave out one of the retirement system types from the regression.
5. The expected value of  $E((ex)(ex)')$  is nonsingular, where  $e$  is the model error term for an individual and  $x$  is a vector of that individual’s characteristics. The apostrophe means the transpose of the vector. Another way to say this would be that the expected values of the error terms conditional on the explanatory variables is zero. This assumption is similar conceptually to assumption three but it is more strict, and this description is a simplification.

If all five of those assumptions hold, the model’s estimated effects of the data on the dependent variable can be expected to have a normal, meaning bell-shaped, distribution as the sample size gets very large. That allows for estimating whether the estimated effects are significantly different from zero, which is what I want to know.

The conditions above are in general terms. See appendix two for technical details and some justification for why I believe these data meet the criteria. Also see appendix two for what it means to have a “good” estimator.

## Model Specification and Choice

I chose models by first verifying each of the assumptions listed above. The model meets assumption four if I choose explanatory variables that do not perfectly predict each other, so I do not test for it explicitly. In order, my selection criteria included the following tests:

- Test of functional form misspecification using a RESET test. See appendix two and Wooldridge (2006), p 308 for details. This test re-estimates the model with squared and cubed versions of the original model's fitted values, as a general test of whether the explanatory variables have a significant non-linear effect on the dependent variable.
- Regression errors (residuals) centered at zero. Graphical assessment and calculation of the average.
- Residual covariance is zero for all x-variables and plots of residuals do not show any obvious patterns, other than a random scatter around zero. Criteria b. and c. together suggest assumption three holds, but they do not make for an explicit test. See appendix two.<sup>39</sup>
- Adjusted R-squared value comparison for non-nested models. F-test for nested models. A nested pair of models would be the case in which one model is the same as the other model except for added explanatory variables. For example, models one and four are nested because model four is model one with the square of age added and nothing else changed.

Model	Dependent Variable	Explanatory Variables
<b>One</b>	log(Average Earnings)	ben_rtw.weekly, ben_rtw.weekly:school, ben_rtw.weekly:school.stre, school.stre, tsters, age_rtwbegin, rtwlag, sp500.lag1, priv_gsp.B, gov_gsp.B, unc, comcol, nrtw, medicare, socsec_any, post09_rtwbegin, active, afc.weekly
<b>Two</b>	Average Earnings	same as one
<b>Three</b>	log(Average Earnings)	same as one, except benefit variables are in log form
<b>Four</b>	log(Average Earnings)	same as one, except with an added variable age_rtwbegin^2
<b>Five</b>	log(Average Earnings)	same as four, but all benefit values are replaced with squared values for the interaction terms and there is an additional squared benefit term on its own
<b>Six</b>	Average Earnings	same as four

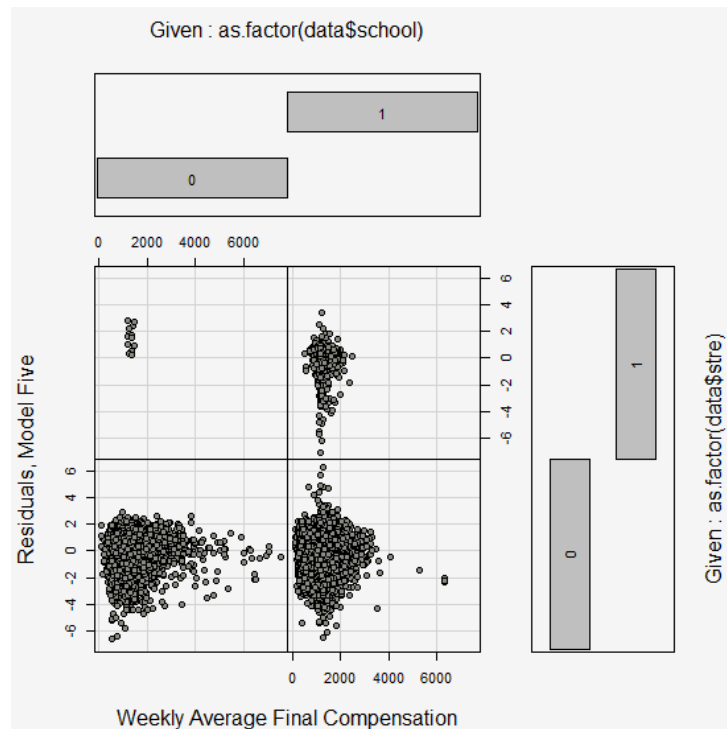
\*Note the symbol ":" signifies an interaction between two variables, meaning one variable is multiplied by the other and the interaction is treated as a different variable. The interactions in models above allow benefit amount to affect school and non-school employees differently.

### *Steps A, B and C*

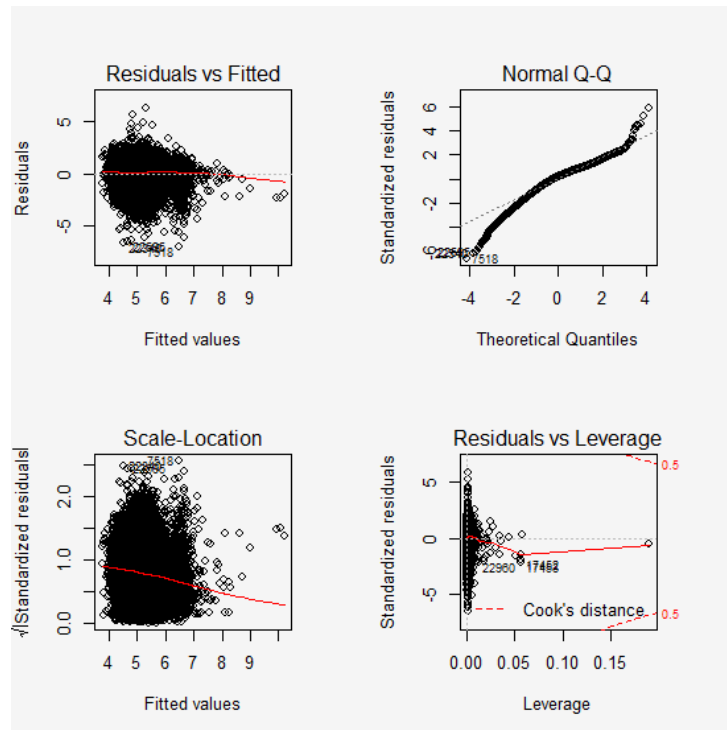
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<sup>39</sup> Hayashi , p. 9 and 111.

All models passed the RESET test, meaning there was no obvious functional form misspecification.<sup>40</sup> All model residuals had average values very close to zero, and scatter plots showed they were centered and symmetric around zero with a slight skew toward more negative residuals. That held when plotting residuals with the fitted values of the dependent variable and for different important groups, such as those who were school employees and exempt from earnings limits. Examples of those kinds of plot for model five are below. Though the residuals for school and exempt employees are clearly shifted to the right, that is because fitted values for those employees are larger, not because the residuals themselves show a trend. Some residuals peek downward, but those are few relative to the mass centered around zero.



<sup>40</sup> Wooldridge, p 308



The “q-q plot” above shows how well the residuals match a standard normal distribution. The residuals distribution is heavier at the negative end. But unlike for smaller samples, large samples do not require the residuals to have a standard normal distribution to make valid inferences about the relationships between explanatory variables and the dependent variable. The residuals need only be centered at zero and orthogonal to the explanatory variables to make valid inferences about the least-squares estimated coefficients.<sup>41</sup>

Based on steps A, B and C, there was no clear reason to rule out any of the models.

#### *Step D*

R-squared is a measure of how well the model fits the data. The more of the variation in the dependent variable a model can explain, the bigger its R-squared statistic. Adjusted R-squared measures account for the fact that models with more variables will explain more of the variation, just because they have more explanatory variables. A model does not need to explain all or even a large part of the variation in the dependent variable to estimate the relationships between variables accurately.<sup>42</sup>

All of the models with a logged dependent variable had similar adjusted R-squared statistics, from 0.19 to 0.20. Models with the unlogged dependent variable had much lower adjusted R-squared values, around 0.05. That clearly indicated models with a logged dependent variable fit the data

<sup>41</sup> Hayashi, p 109

<sup>42</sup> Wooldridge, p 208

better. Often, economic analyses use the log of wages as dependent variables in regressions, so that result is not very surprising.

R-squared values for the models with logged dependent variables were close enough to be of no help in distinguishing among them. Since model one was nested in model four, I used an F-test to determine whether model four's additional squared age variable added enough explanatory power to make model four and model one significantly different. The F-test showed no significant difference between the two models, so I dropped model four in favor of the simpler one. See appendix three for my calculations.

Ultimately I chose to present information for models one and five, which included quadratic terms for benefit amounts and age. I did so for to give two different models to estimate the effect of retirement benefits on earnings in retirement. Model one describes a straight-line relationship, and model five describes a curved relationship. The two led to similar conclusions, and I had no good reason to choose between them. I include results in appendix one for both models one and model five.

Regardless, models one, three, four and five all showed similar relationships between benefit amount and the dependent variable. If the models gave incompatible results, my choice of model would matter more the results.

## Results: Earnings in Retirement

My results suggest that, on average, retirees were willing to work for less the more they received in benefits, controlling for compensation at retirement and other factors. Again, you could interpret that to mean retirees with more years of service were willing to work for less in retirement. See the note above. However, in one of the two final models I found the opposite relationship for retirees who returned to work in public schools.

Controlling for the other factors in the model, I estimated:

- Retirees who work for their former systems while continuing to earn their benefits do seem willing to work for less, as their benefits get larger.
- For example: A 1-percent increase in weekly benefit amount at return to work was related to an 0.08 percent decrease in earnings during retirement, for non-school, non-exempt retirees with average fitted values and average benefit amounts. Again, that holds constant a person's pre-retirement compensation.
- Retirees with higher pre-retirement compensation I estimated to have higher earnings when they returned to work, holding constant all other factors, which makes sense.
- For non-exempt school employees, I estimated the relationship between earnings and benefit amount to be positive in one model. See below for details.
- In the model that allowed the effect of benefit amount on earnings to be different depending on the size of the benefit, the effect grew stronger for retirees with larger benefits.

I report estimated effects of retirement benefit amount on earnings in terms of elasticities: The percent change in the dependent variable you would expect to see from a one-percent change in the benefit amount at return to work, controlling for all other factors in the model. Since I am ultimately interested in earnings, not its logarithm, I first transform to logged dependent variable into its fitted un-logged form. See appendix two for details. In the paragraphs below I call unlogged earnings the “fitted value”.

Results below come from two models, one in which benefit amount was included in the model as a squared variable and one in which it was not. Including benefit as a quadratic function allows the change in earnings from a unit change in benefit amount to be different depending on how much a person makes. I included both results because both made it through the series of criteria I set up to evaluate the models. The two models both estimate that earnings in retirement decrease as retirement benefit increases for non-school, non-exempt retirees. The models differ in their estimated effects for retirees who fall into those groups.

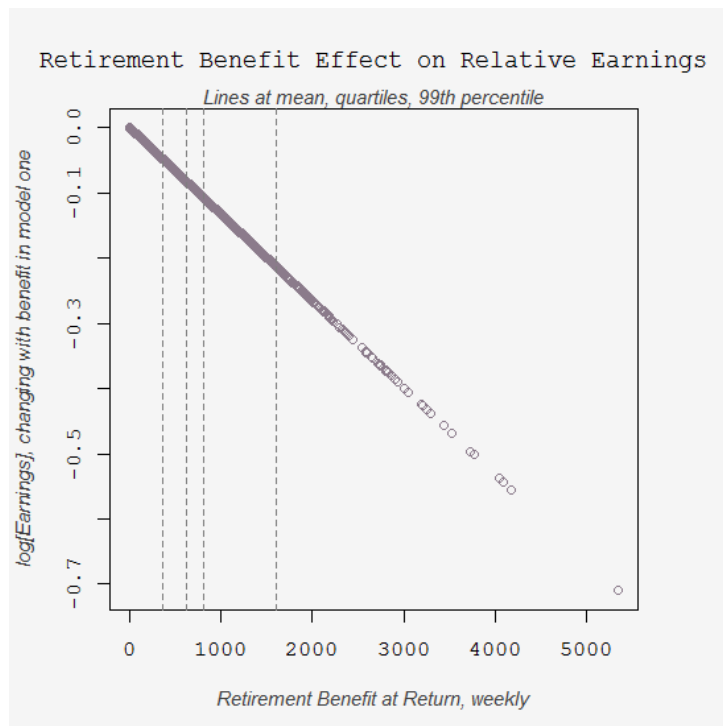
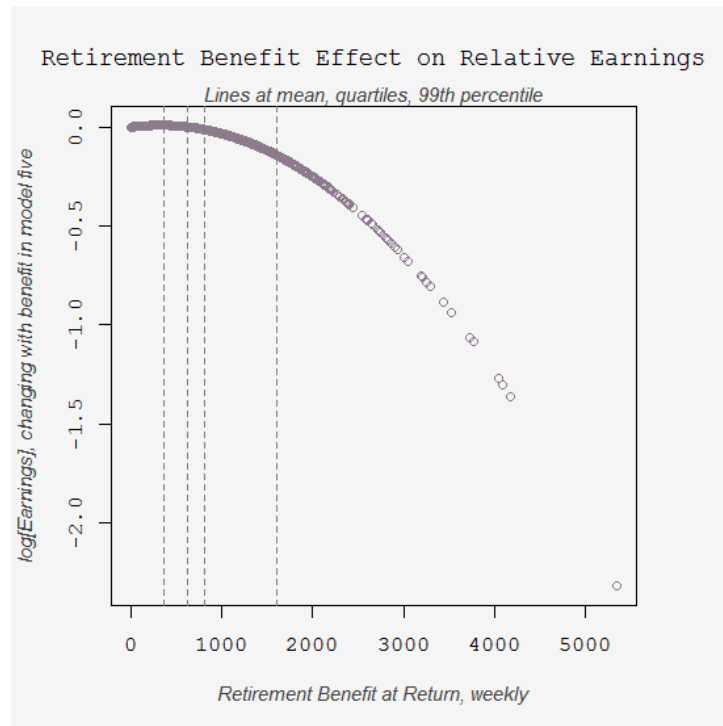
The table below reports elasticities from models one and five. Since both models included interaction terms with 0-1 indicator variables for retirees working in schools, the effect of benefit on the ratio of earnings to final compensation changes depending on whether a retiree fits in that group.

Model	Non-School, non-exempt				School, non-exempt	School and exempt
	Means	25th pctl	75th pctl	99th pctl	Means	Means
1	-0.08152	NA	NA	NA	-0.08078	-0.08222
5	-0.03301	-0.00247	-0.07231	-0.38146	0.040773	0.030832

Full regression results for both models are in appendix one. The important difference between the models is that model one has no exponential variables: The relationship is a straight line. Model five has benefit amount included as a quadratic. See the second part of this paper for details.

Model one in the first graph instead shows a slightly downward sloping line. Model two in the second graph illustrates how the quadratic model characterizes the relationship between benefit amount and earnings in retirement. Note that the graphs do not give the same numbers as the ones in the table above. The table above gives percent changes for percent changes. The graphs below give the expected unit change in logged earnings for a unit change in benefit.





### *Implications: Earnings in Retirement*

As I said above, one of the most common policy options to offset costs related to easing work restrictions for retirees is to impose a surcharge for employers on the value of a retiree's earnings. These results suggest such a policy could be workable for retirees with larger benefit amounts. The results also suggest it might be worth considering placing valuing the surcharge based on a worker's retirement benefit, as opposed their earnings. Rehired retirees with larger benefits would ultimately earn less under that kind of policy, since employers likely would incorporate the cost of the surcharge into the wages they offer. But if they are willing to work for less, retirees might not be turned off by the lower wages.

My estimates suggest there might be an opposite effect for retirees who worked in schools. For those employees, one model estimated earnings in retirement increased as benefits increased. If that relationship were true, an explanation might be that teachers with long experience could be in high demand, allowing them to command higher wages when they return to work.

## Limitations and Discussion

### *Non-constant error variance*

A common issue to watch out for in linear regression is that the variance of the error terms is not the same for all observations. That means the standard errors of the estimated coefficients are skewed and might create falsely significant estimates. In large samples, you can correct for that inconsistency using a so-called robust estimate of the error variance in the model. I did so using the White "sandwich" estimator. See appendix two for the equation and appendix three for my code to calculate it.

None of the significance levels of the coefficients changed much when using robust standard errors, so I do not report them.

### *Bias from employees exempt from the earnings limit*

I worried that employees who were exempt from the earnings limit would bias the estimated relationships for other explanatory variables. As another check, I re-ran the model without the observations for individuals who worked in schools and were exempt from the earnings limit. The relationships in my results above did not change much at all. Results from this modified regression are in appendix one.

### *Years of service proxy variable*

The three North Carolina retirement systems in this dataset are defined benefit plans, so a person's retirement allowance is a product of years of service, average final compensation, and a small constant factor of around 0.0185. That factor depends on the retirement system and has changed

little over the years. Retirees who do not reach 30 years of service, in most cases, have a reduced benefit amount that does not follow the formula above.<sup>43</sup>

Since final compensation is controlled for in the regression, another way to interpret the effect of benefit is that it captures the effect of years of service as member of the retirement system. I stick with the benefit variable because I did not have years of service in the dataset and chose not to include a proxy variable for it in my final models. I did not want it to appear that I was fabricating data. I did create a proxy variable for years of service and included it in the two final models, replacing compensation and benefit, to see how much that mattered. It didn't, much, but that is not surprising because it is just one of the replaced variables times the other. Full results are in appendix one.

You could choose to think of the results below as capturing the effect of years of service, as opposed to benefit amount. The important points to remember are that: 1) You can't separate the effect of years of service as opposed to benefit on earnings. 2) Not having years of service in the regression does not necessarily bias the results, because information about years of service is embedded in the variable for benefit, with no additional random effects after controlling for final compensation. It would be better, however, if the retirement system were to get an actual measure of years of service and include it in the model. The difference between my proxy variable and actual years of service would come from individuals who retired with reduced benefits.

## **Length of Time Working in Retirement**

### **Model Specification and Choice**

This section is an overview of the concepts behind the models and the variables used to construct each one. See appendix two for the mathematical forms of the most important models for this analysis.

Survival models describe the time between events or the time leading up to a first event. For these data, survival models would describe the likelihood of working a certain amount of time before quitting. Survival models are rooted in the idea that for each unit of time, there is some probability a retiree will quit working.<sup>44</sup>

Survival models can be applied to many problems. Amemiya (1985), ch. 11, gives several examples of economics papers in which survival models like the ones in this paper are used to model lengths of time in employment or unemployment before quitting. For example, Amemiya says Heckman and Borjas (1980) used a Weibull distribution to model periods of unemployment. The Weibull is the one I ultimately use for this paper's results.

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<sup>43</sup> N.C. G.S. 135-5

<sup>44</sup> Cameron A. and Trivedi, P., p 161

## Model Assumptions

Each of the models used here assumes that the outcome variables are independently and identically distributed random variables, conditional on the data. For example, the probability that a person with a set of characteristics works a number of months in retirement does not change based on how long another person with the same characteristics works in retirement. It also means the same function will describe the probabilities of time in retirement for people in the dataset.

As with linear regression analysis, the model includes coefficients that interact with values of a person's characteristics. For example, there is a coefficient that describes how being a school employee influences the length of time a person works in retirement. The model chooses coefficients that maximize the model's likelihood function. In other words, it chooses relationships among a person's characteristics and the length of time in work that maximizes the probability a person with those characteristics would work that length of time. A model that perfectly described that relationship would have give a probability of one.

Probabilities are small numbers, particularly when multiplied across thousands of observations, so the model instead maximizes the natural logarithm of the likelihood function. The log of a tiny number, say .001, would be a large negative number. A perfect fit would give a log-likelihood of zero. In the log-likelihood results below, numbers closer to zero represent a better model fit.

Each of the models I tested assumes the effect of a person's characteristics is to increase or decrease the probability of working a particular amount of time. For example, it might estimate the probability of a non-school employee works 52 weeks before quitting is the same as the probability of a school employee working twice that long before quitting. In equation form:

$$S_{no\ school}(t) = S_{school}(\delta t)$$

where  $S(t)$  is the probability of surviving at least to a particular time before quitting, and  $\delta$  is a number that describes how being a school employee affects that probability.<sup>45</sup>

That relationship is an assumption. If the true relationship between those two probabilities is exponential, for example, then the model will not describe the effect of being a school employee on work time in retirement very accurately.

See appendix two for specific functions and other math related to the models.

## Model Selection

I tested models fitting six different types of models, shown in the table below. Model types refer to the form of the likelihood function and other functions that it assumes to describe work times in retirement. The log-likelihood statistic is the same as the one described in the section above. A log-likelihood closer to zero means the model fits the data better. In all models, the dependent variable was the length of time working in retirement, in weeks.

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<sup>45</sup> Kleinbaum and Klein, p 298

Model Type	Log-Likelihood	Explanatory Variables (see above for reference)
<b>Exponential</b>		ln_diff, ln_diff_ben, school, school.stre, unc, comcol, tsers, sp500.lag1, rtwlag, priv_gsp.B, gov_gsp.B, post09_rtwbegin, nrtw (control only), medicare, socsec_any
<b>Weibull</b>		same
<b>Logistic</b>		same
<b>Log-Logistic</b>		same
<b>Log-Normal</b>		same
<b>Normal</b>		same

### Selection Process

I used the following process to evaluate model fit:<sup>46</sup>

1. I compared model log-likelihood statistics for different types of models using the same explanatory variables, as shown above. Models with similar log-likelihood statistics fit the data essentially equally.
2. Among the best-fitting models, I evaluated the distributional assumptions and chose the model for which those assumptions were most consistent with the data. For example, the exponential model assumes the instantaneous probability a person stops working is the same no matter how long that person has been working.
3. For the chosen model type, I tested different forms of the explanatory variables. For example, I checked whether the log of benefit amount or the squared benefit amount was a better fit in describing the lengths of time retirees worked.

### Step One

Only the normal and logistic models were clearly worse than other models. I kept the exponential, Weibull and log-normal models for further comparison.

### Step Two: Exponential and Weibull

Exponential and Weibull survival models assume all individuals have the same baseline instantaneous probability of quitting work at a given period of time, called the baseline hazard.<sup>47</sup> A simple way to get a sense of whether that assumption holds is to graph  $\log(-\log(S(t)))$  for two different groups of retirees, where  $S(t)$  is the Kaplan-Meier estimate of a retiree's probability of working at least  $t$  weeks without quitting. See two for more information and appendix three for the specific calculations.

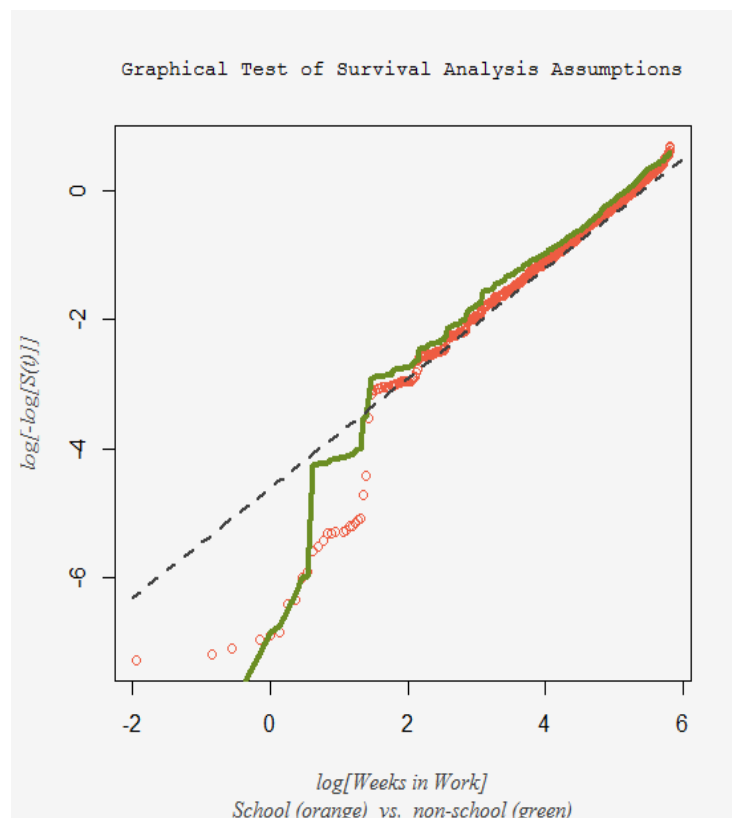
The important things to know are that if the model is a good fit, the line for one group of retirees will be parallel to the line for the second group of retirees, and both lines will be straight.

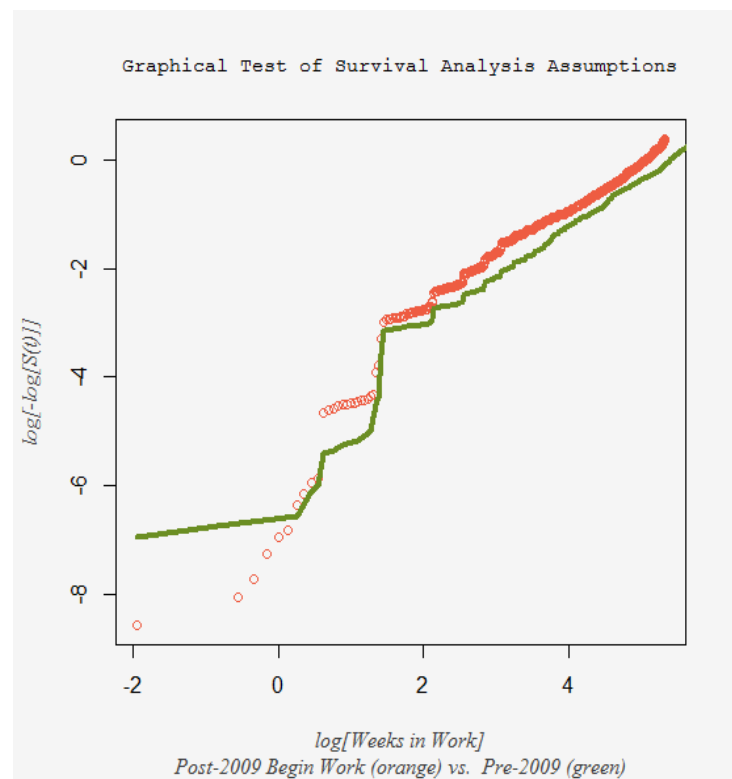
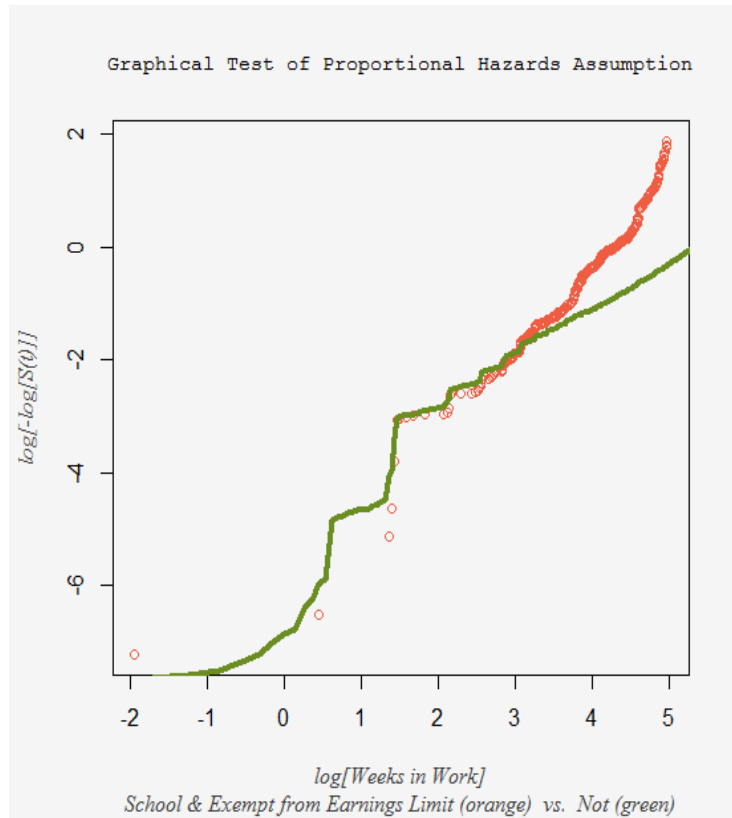
<sup>46</sup> Cleves et al., p 270

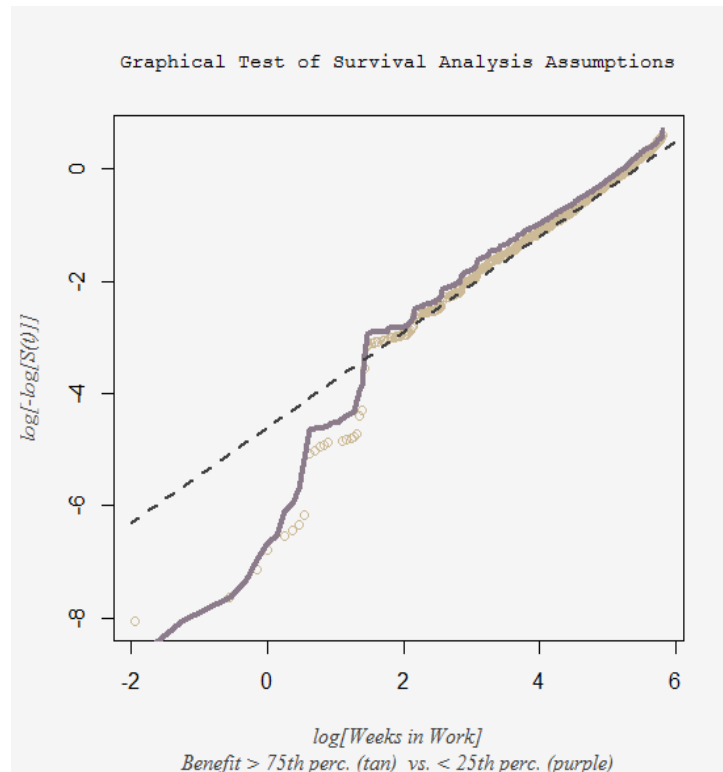
<sup>47</sup> Kleinbaum and Klein, p 305

The graphs below show a few things:

- the exponential and Weibull models seem appropriate for describing how long most different types of individuals in the dataset work in retirement.
- the models are not at all appropriate for individuals who work less than a month or so. The x-axes give values of the natural logarithm of weeks worked in retirement. Zero on the x-axes means one week of work in retirement before quitting, since the log of one is zero. Individuals who worked less than about 5 weeks – whose log is 2 – have very non-linear points on these graphs. About 1,500 people worked 5 weeks or less in the dataset – a small but not insignificant number. I come back to this later and re-estimate a model without those observations to see how much they matter.
- the models' assumptions of proportionality do not hold when comparing individuals who are school employees and exempt from the earnings limit to those who are not.







If the straight line in the has a slope of one, the exponential model is a good fit, and it means the probability a retiree quits working at any given time is the same no matter how long they have already worked. If the straight line has a different slope, it suggests the probability a retiree quits working in a given week changes depending on how many weeks he or she has worked up to that point. A Weibull model would fit better, in that case.

The graphs suggest a Weibull model fits better than the exponential one, since I set the dotted lines to have slopes of slightly less than one.

There is another way to test whether an exponential or Weibull model fits better. The Weibull regression estimates the slope of the line as a matter of course and tests whether it is significantly different from one. Again, if the slope were one, the exponential model would fit better. The Weibull regression estimated a slope of 0.937, which was significantly different from one at significance less than  $p=0.0001$ , again suggesting the Weibull model fits better than the exponential.

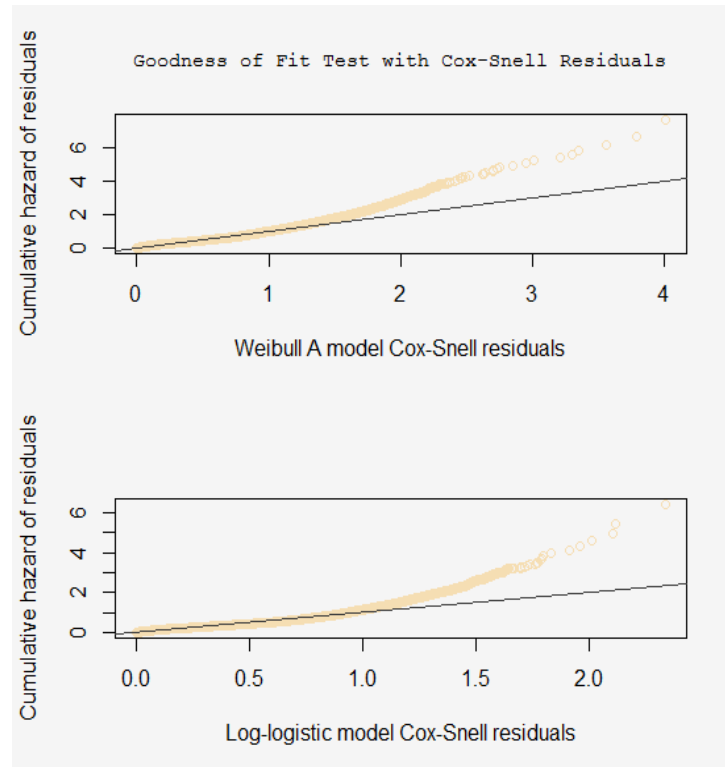
I ruled out the exponential model for those reasons.

### *Step Two: Log-logistic and Weibull*

To choose between the log-logistic and Weibull distributions, I used another set of graphical tests. The first plots the Nelson-Aalen cumulative hazard estimates of the Cox-Snell residuals. Those names mean nothing outside of the context of survival analysis, but the important thing to know is that if a model fits well the graphs should follow straight lines. See appendix two for details.



I made those plots for the log-logistic and Weibull models. Both were basically the same. Neither had a perfectly straight line, and that is OK. Often models will have curves that bend one way or the other toward the right-hand side of the graph.<sup>48</sup> But this graph does not help eliminate one model or the other.

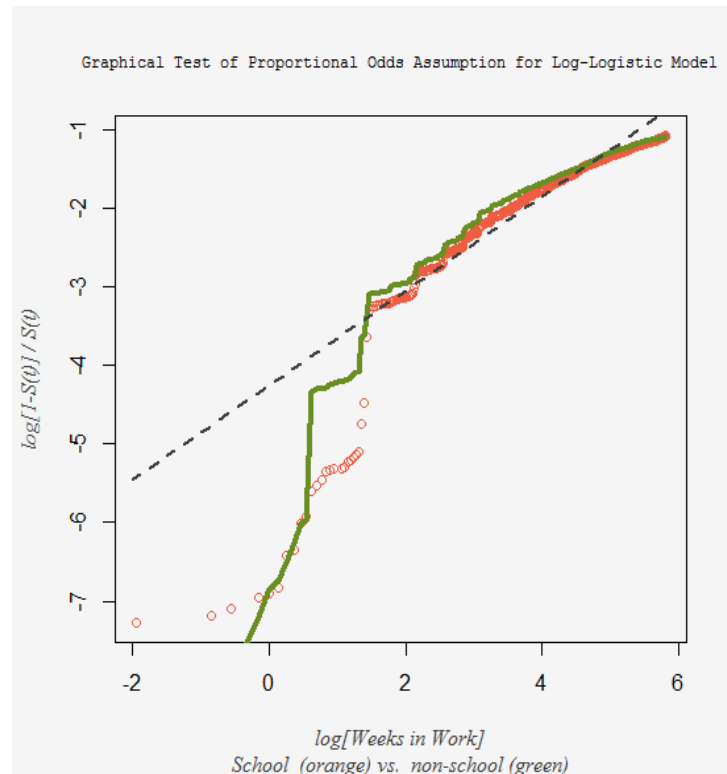


As with the Weibull and exponential models, the log-logistic model has a basic assumption: It assumes that the ratio the probability of working at least a certain length to the probability of working less than that is constant for all lengths of time. For example, if you are twice as likely to work at least one year as you are to quit before one year, then you must also be twice as likely to work at least two years as you are to quit before two years. You can test that assumption using a graph, and the assumption holds if the lines for two groups are straight and parallel.<sup>49</sup>

The graph's curve along the right side indicates the log-logistic model's assumptions don't hold up as well as the Weibull model's does, based on the graphs above. For that reason, I chose the Weibull model – one of the most common models used in survival analysis.

<sup>48</sup> Cleves et al., p 216

<sup>49</sup> Kleinbaum and Klein, p 310



### *Reason for not testing Cox proportional hazards model*

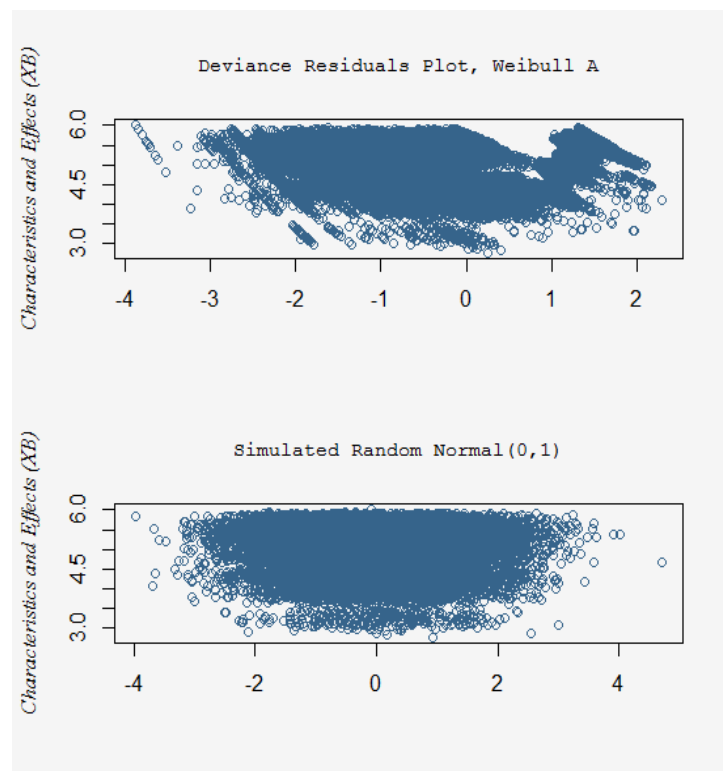
Readers familiar with survival analysis might wonder why I didn't choose to test a common model, called the Cox proportional hazards model. The reason I didn't is that the Cox model does not allow for an intuitive interpretation of how a person's characteristics affect how long he or she will work in retirement. Unlike the models above, the Cox model does not allow you to interpret the effect of retirees' characteristics on their probabilities of working at least particular length of time in retirement. As the name suggests, the Cox model primarily is designed to compare hazard functions – the instantaneous probabilities of an event occurring. The Cox model makes fewer assumptions than the models above. Since the Weibull model's assumptions hold pretty well in this case, and its results have a more meaningful interpretation, I avoided the Cox model altogether.

### **Step Three: Choosing Forms of Explanatory Variables**

After finding a Weibull model to work best, the question was whether I should include different forms of explanatory variables. For example, should the retirement benefit amount be included in the model as a logarithm or not? One way to test that is to plot the deviance residuals of different models over the observed characteristics, times the model coefficients. The details are in appendix two, but the important thing to know is that a better model will have a graph that looks more or less like a random scatter around zero.

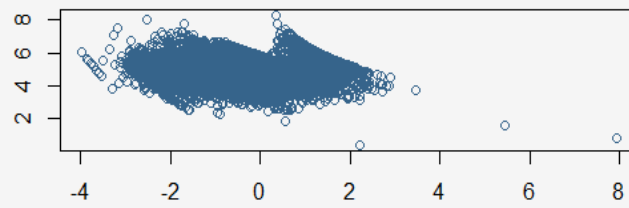
I tested seven Weibull models with different forms of benefit amount and age in the explanatory variables. Model A is the one with the explanatory variables listed in the model selection table, above. It turned out to be the one with that performed best on this test, as well.

Graphs below show that models with benefit or age in quadratic form led to skewed deviance residuals. In each graph, I plot a random scatter of normally distributed data with a mean of zero for the sake of comparison. Details about which mixes of explanatory variables I used are in the appendix with my code.



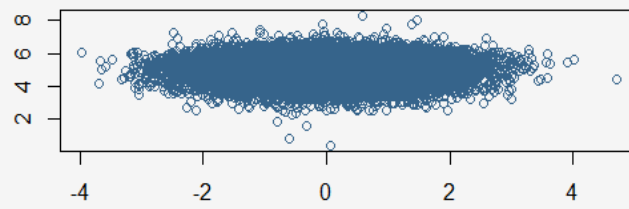
Characteristics and Effects (XB)

Deviance Residuals Plot, Weibull B



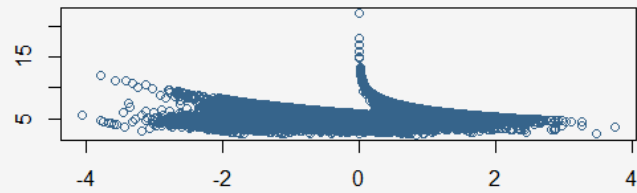
Characteristics and Effects (XB)

Simulated Random Normal(0,1)



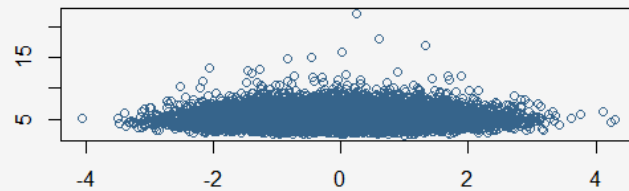
Characteristics and Effects (XB)

Deviance Residuals Plot, Weibull F



Characteristics and Effects (XB)

Simulated Random Normal(0,1)



Model A and model B are similar and much less skewed than model F. Model F's large spike in the middle suggests the functional form of the explanatory variables is off. Other models had deviance residual plots that looked similar to F's and I chose not to include them. The only difference between model A and model B is that model B includes age at the time a person quit working as an explanatory variable. I worried about including that variable. The Medicare and Social Security variables both are tied to a person's age when they start working. Together with the dependent variable, length of work in retirement, they very closely predict the age of a person at the end of retirement. To avoid such problems, I chose model A. Also, model A did not have the large outlier model B did, at the far right-hand side of the graph, suggesting model A was a slightly better fit.

## Results: Length of Time Working in Retirement

Full results tables are in appendix one. The intuitive interpretation of the results is in terms of acceleration factors – the proportion by which retirees' expected probability of working a certain amount of time grows or shrinks based on their characteristics. Estimated acceleration factors are below:

Variable	Acceleration Factor Estimate
<b>ln_diff +0.22</b>	1.013889585
<b>school</b>	2.431862558
<b>tsers</b>	0.437434483
<b>unc</b>	2.60429882
<b>comcol</b>	2.415769925
<b>sp500.lag1 +10</b>	0.986351574
<b>priv_gsp.B +10</b>	0.725654147
<b>gov_gsp.B +10</b>	1.200688737
<b>rtwlag + 1yr</b>	0.99530679
<b>post09_rtwbegin</b>	0.575566766
<b>socsec_any</b>	0.843742198

An acceleration factor greater than one increases the amount of time a person in retirement might be expected to work. An acceleration factor less than one decreases that time.<sup>50</sup> The plus signs refer to how large an increase in the variable the acceleration factor is calculated for. For example, a retiree who begins working in a year where the private gross state product is \$10 billion more would have a probability of working only two thirds the amount of time than a retiree who begins working without that increase in gross state product.

I did not include factors for coefficients that were not significantly different from zero. See appendix one for the full results.

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<sup>50</sup> Cleves et al. p 257

The results make common sense, and I interpret them this way:

- A larger ratio of earnings in retirement to compensation before retirement extends the time a person works in retirement, as shown in the coefficient for  $\ln\_diff$ , controlling for the other factors.
- Retirees who worked in schools could be expected to work two and a half times longer than those who did not work in schools. Working at a university or community college had a similar effect.
- Retirees from TSERS who were not university, school, or community college employees could be expected to work only half the time an LGERS retiree works.
- More economic activity in the private sector is related to shorter work times. One explanation might be that retirees or their spouses are able to find better-paying work in the private sector when private sector output is higher, pulling them away from work for public employees.
- Retirees who started working Jan. 1, 2010 or later could be expected to work just about half the time of employees who started working before then, all else equal. That effect is estimated while controlling for the fact that some retirees before 2010 were exempt from the earnings limit.
- Being eligible for social security benefits also shortened the time a retiree might be expected to work, though since age itself is not controlled for in this model it's unclear whether that effect is because of age or because of social security benefits themselves.

## Limitations of Results

It is clear from the graphs in step two, above, that the results probably do not do a good job describing factors influencing how long certain groups of retirees work. Those who work less than a month or so have different survival curves, which this model doesn't fit very well. The same is true for school employees who were exempt from the earnings limit. Therefore I do not include an acceleration factor for that group in the results above.

The question is whether those aberrations bias the results for other groups. I re-estimated the model twice, once without retirees who were exempt from the earnings and limit and who were not school employees, and again without retirees who worked less than a month before quitting. Neither changed the results of model A much, as shown in the tables in the second appendix.

## ADDITIONAL REFERENCES

References for sources other than articles or websites are included in the briefs with names and page numbers only. The full references for those citations, and other resources I used to help me with this paper, are:

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